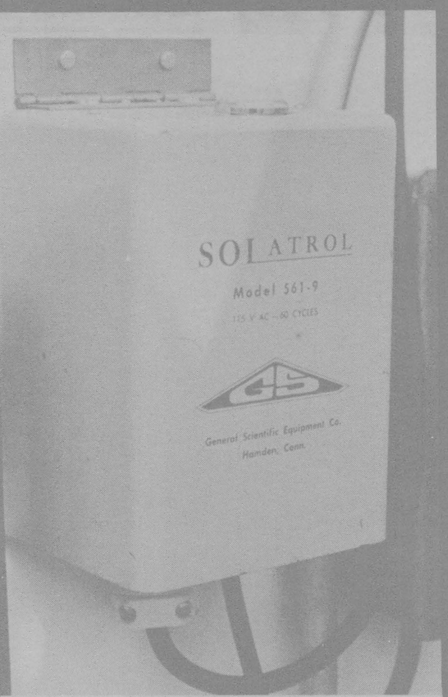
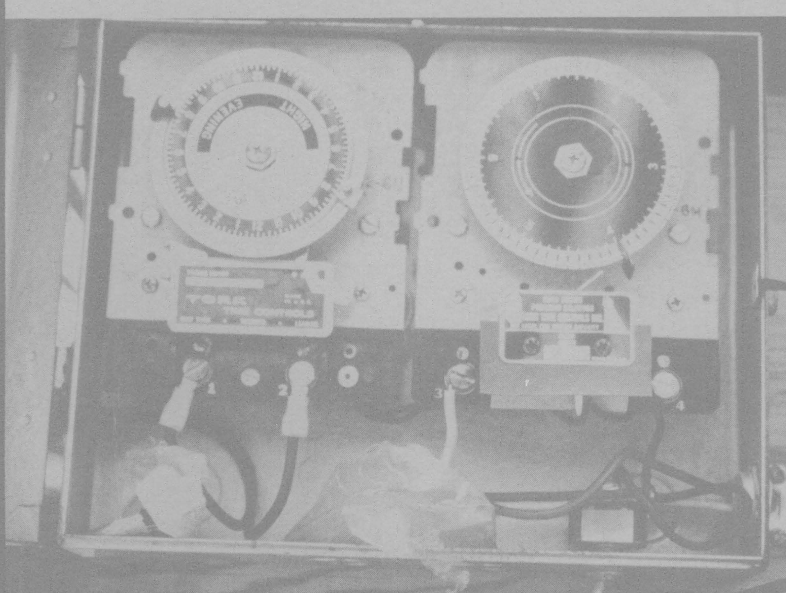


INTERMITTENT MIST PROPAGATION



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CONTENTS

To achieve successful rooting of cuttings, one must prevent wilting due to excessive transpiration.

Older methods used in the vegetative propagation of plants to increase humidity and subsequently reduce wilting during the rooting period have involved heavy shading, reducing leaf area, frequent hand watering and various types of enclosures. These practices, however, greatly reduced photosynthesis, thereby causing a slower rate of root initiation and development.

In recent years, the utilization of intermittent mist has resulted in increased successes with the rooting of cuttings and consequently has changed many of the older propagation practices. With intermittent mist, cuttings of many species can be rooted under high light intensities with little or no leaf scorch. This is possible due to the maintenance of high atmospheric relative humidity during the rooting period. In addition, intermittent mist provides a cooling effect as water is evaporated from the leaf surfaces of the cuttings. Thus with intermittent mist, transpiration is reduced, leaf tissues are cooled, respiration is reduced and photosynthesis continues, allowing the production of carbohydrates necessary for rapid development of the root system.

A schematic diagram illustrating the component parts of an intermittent mist system is shown in Figure 1. Various systems with and without environmental overrides give the propagator several alternatives to best meet his needs.

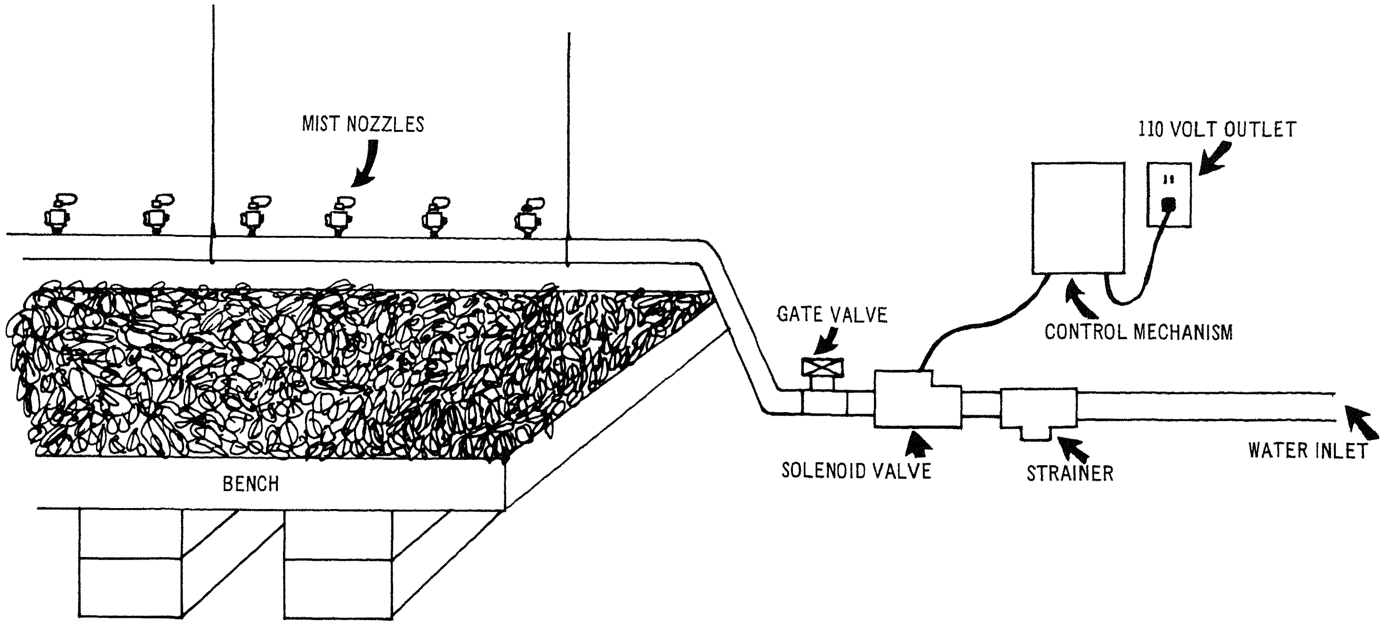

Fig. 1: Schematic diagram of the overall mist system. The intent of the authors is to briefly review the component parts and operations of the systems of intermittent mist to better guide plant propagators or others interested in this subject.

TYPES OF MIST

In general, misting techniques may be classified into two types, continuous mist and intermittent mist. With continuous mist, a fine spray of water is applied continuously to the cuttings during the rooting period. Continuous misting may lower the temperature of the rooting media below the optimum for rooting and cause excessive leaching and deterioration of the foliage. In addition, if drainage is poor, the excess water used in the constant mist system may displace oxygen in the media, resulting in poor root development and decay of stem tissue.

Controlled intermittent mist (i.e., mist "on" for a period of time and "off" usually for a longer period) reduces the amount of water used when compared to continuous mist and can alleviate the waterlogged soil condition that often results with the use of constant mist.

With intermittent mist systems a control mechanism and solenoid valve are required. The control mechanisms may be of various types, including timing devices, humidistats, light operated devices and electronically controlled units. More discussion of these specific units follows.

INTERMITTENT MIST INSTALLATION

Construction and design of the propagation bench will vary with the needs of the propagator. For purposes of intermittent mist propagation, 2 types of benches can be constructed, the ground bed and the raised bed. Ground beds are most commonly employed where intermittent mist propagation is done in outside conditions, while raised propagation benches are most commonly used in greenhouse or plastic covered structures.

Regardless of the type of bench, size will depend upon the needs of the propagator. Length of both ground or raised benches will vary, depending on the facilities and particular needs of the propagator. Both raised and ground beds should not exceed 60 inches in width, so the center can be easily reached from both sides of the bench. With raised benches, height varies from 30 to 36 inches, depending upon the type of construction.

Once the type of bed has been decided, there are 2 types of installation for the intermittent mist lines—overhead and in-bench. For ground beds, in-bench mist lines are most commonly employed, as there is usually no means for support for overhead mist lines. Raised beds constructed in greenhouses or fiberglass houses are usually equipped with overbench mist lines attached or strung with wire from the crossties.

With overhead systems, the supply line and nozzles hang over the center of the propagation bench. This type of installation is particularly useful with the newer types of deflection nozzles which are installed by drilling and tapping into either galvanized or polyethylene pipe, so no "T's" are required. In addition, the overhead mist system is generally easier to install and maintain than the in-bench system, as all parts are readily accessible.

The main disadvantages of the overhead mist system is that it is very susceptible to wind if used in the outdoor situation, making it imperative to use a wind screen in order to protect the cuttings and insure complete mist coverage.

With in-bench mist installation, the supply pipe runs along the bottom of the bed or bench either under the rooting media or directly on the surface of the media. The nozzles are placed on upright pipes attached to the supply line with "T's". In general, the nozzles in the in-bench type mist systems are 14 to 18 inches above the media. When permanently installing the in-bench mist system, the supply line should be placed under the media so it will not take up space which can be used for propagation. Placing the mist line on top of the

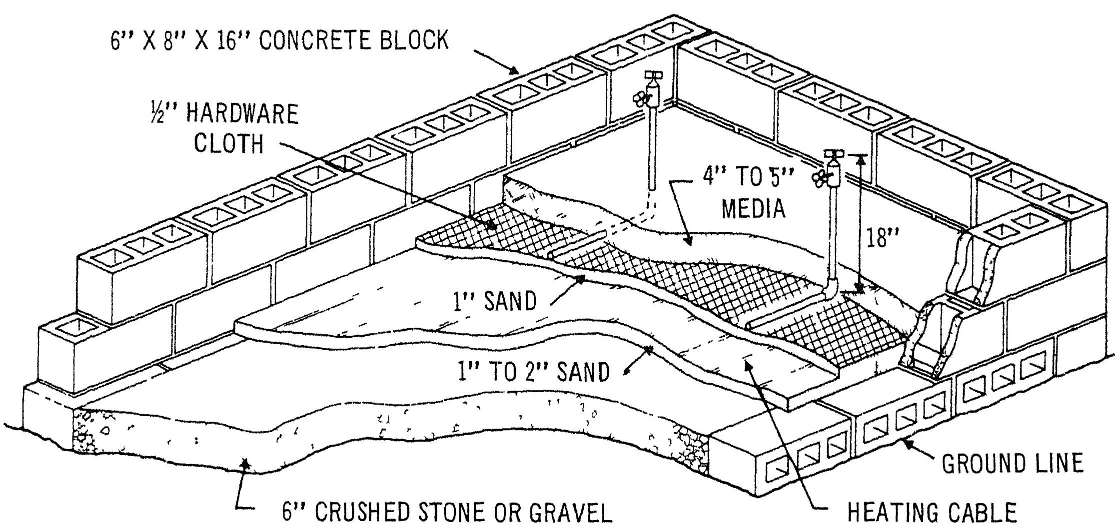

Fig. 2: A cutaway view showing construction of a ground bed for outside propagation. Width of bed shown in 60 inches. Nozzles are spaced 30 inches apart and 15 inches from side and end of bed. The first run of concrete blocks is laid horizontally for drainage.

media is useful when the propagator wishes to leave the cuttings in the media but wants to move the mist line to another bench.

When using the ground bed, in the outside situation, a polyethylene or burlap wind screen 2-3 feet high should be constructed around the propagation bench to eliminate the problem of wind drift.

STRAINERS

The inclusion of a line strainer in the mist system is an integral part of the total system and is one of the most inexpensive items which can be used in a propagation system to help insure long solenoid and mist nozzle life. The major purpose of the strainer is to filter water prior to its passing through the solenoid, thereby preventing damage to the valve. In addition, the line strainer also helps to reduce the chances of clogging occurring in the mist nozzles themselves.

The most common type strainer used is the "Y" type which includes an 80 to 100 mesh screen basket. The basket can be cleaned periodically. In addition, straight-flow and "T" type strainers are available with removable screens for maintenance.

Price of strainers varies, depending upon size, type and source of supply.

SOLENOID VALVES

In any propagation system involving the use of intermittent mist, a solenoid valve is essential (Figure 3). Basically, the solenoid is an electrically operated valve used to control the flow of water through the misting system. Solenoid valves are available in 2 types, the "normally-open" valve (Figure 5) and the "normally-closed" valve (Figure 4).

The normally-open solenoid valve is constructed to allow water to pass through the valve when the electric current is off. When electric current is applied to the normally-open solenoid, the valve closes, shutting off the flow of water. The normally-open solenoid valve offers the greatest possible protection to the propagator in the case of power failure. In this type of situation the mist would run continuously and protect all cuttings from drying out. Where the normally-open solenoid valve is

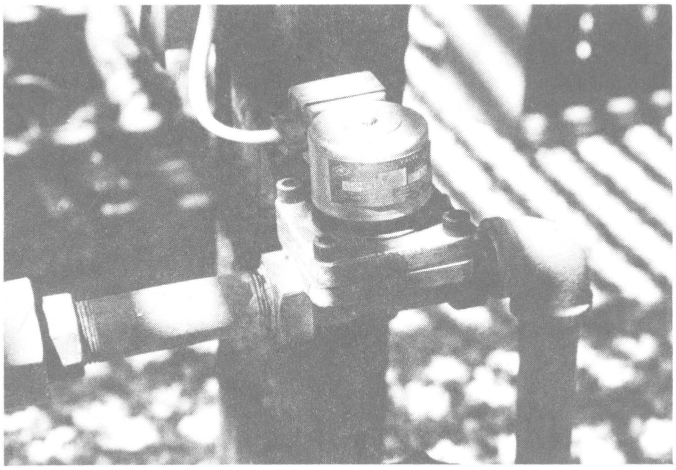

Fig. 3: Solenoid valve.

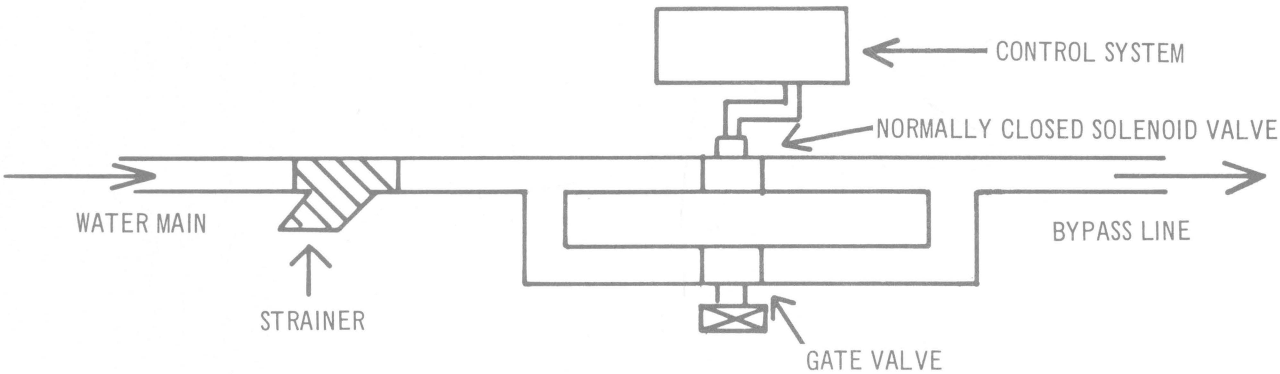

Fig. 4: Schematic diagram of mist system utilizing a normally closed solenoid valve.

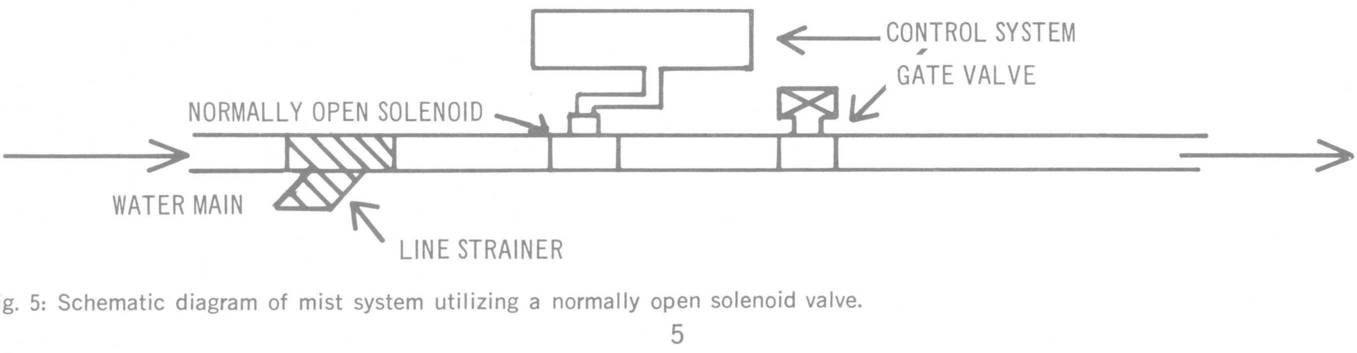

Fig. 5: Schematic diagram of mist system utilizing a normally open solenoid valve.

used, it is often recommended that a manual gate valve be put in the same line to act as a manual off-on valve if power failures occur (Figure 5).

The normally-closed solenoid valve is the more commonly available type unit and is often a few dollars cheaper, initially, than the normally-open type. The normally-closed solenoid is open only when the current is turned on by some type of control device. This type of solenoid valve will operate as efficiently as the normally-open valve but has the disadvantage of remaining closed when the electric current is off. When using this type of solenoid, it is recommended that a bypass be built into the system so that in times of power failure the mist can be manually operated (Figure 4).

Solenoid valves vary in cost, depending upon the source, type—either normally-open or normally closed—and size of the valve.

In addition, it is often a good practice to include a 24 volt transformer along with a solenoid valve to reduce the line current from the normal 120 volt. As a solenoid is often close to wet conditions, this is often a rather inexpensive safety item to include.

MIST NOZZLES

Basically, there are two types of mist nozzles available for plant propagation: (1) Oil burner types (Figure 6) and (2) Deflection types (Figure 7).

The oil burner nozzle is still used in plant propagation but not to the extent it once was due to its high initial cost. This type of nozzle produces a finely distributed spray, achieved by passing a stream of water through small grooves set at angles to each other. While the major advantage of the oil burner type nozzle is its use of only small volumes of water (2.5 to 5 gallons per hour), it requires water pressures of 50-100 pounds per square inch to operate satisfactorily. In addition, oil burner nozzles cover a relatively small area per nozzle (3⅓ to 4 feet), thus requiring a greater number of nozzles per given area of bench space to achieve adequate coverage. Another disadvantage of the oil burner nozzle is the frequency with which it becomes clogged.

The deflection nozzle is by far the most commonly used by propagators today. It produces a rather coarse spray in that a stream of water strikes a flat surface, thereby producing the mist. While the large opening reduces the chances of clogging, the volume of water used is greater, varying from 4 to 20 gallons per hour. In general, the deflector type nozzle covers a greater area, so a smaller number of nozzles can be used in design of the mist bench. An additional advantage of the deflection type nozzle is that it will operate with water pressures as low as 20 pounds per square inch.

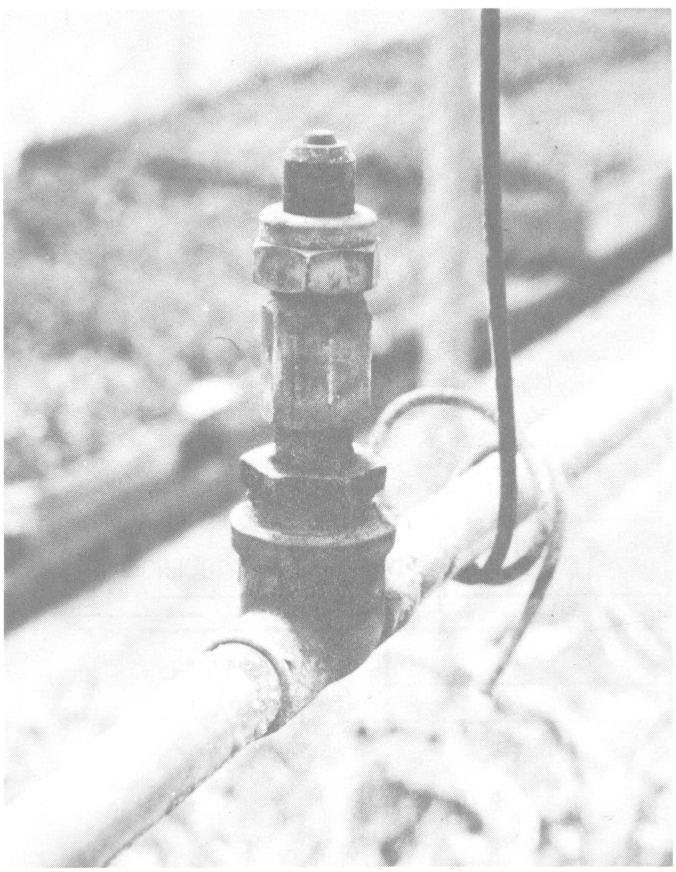

Fig. 6: Oil Burner type nozzle.

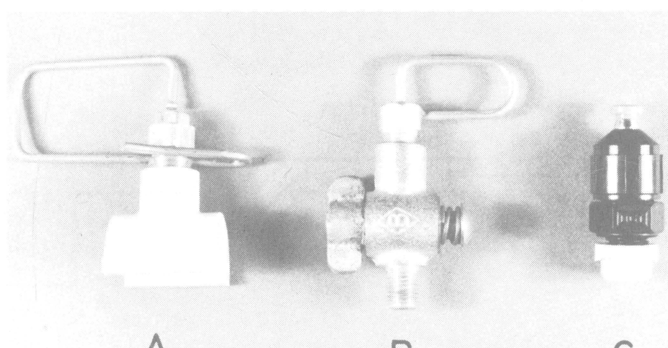

Fig. 7: Deflection nozzles, left to right, A. Flora-Mist Fogger No. 300 with Flora-Mist Pipe Saddle, B. Jed-Mist Nozzle with Jed-Mist Petcock, C. Eddy-Mist Nozzle.

Selection of intermittent controlling systems presents some problems to the propagator, as several different types of systems are commercially available. Intermittent mist propagation systems can be constructed in one of three different modes:

(1) **Preset system without environmental overrides.**

(2) **Preset system with an environmental override.**

(3) **Variable system completely dependent upon the environment.**

Although all 3 types of systems have been used successfully by plant propagators, the variable system which is completely dependent upon the environment is the most sensitive and is the most highly recommended system.

A. PRESET SYSTEMS WITHOUT ENVIRONMENTAL OVERRIDES

Environmental conditions have no influence on the misting frequency or duration of the mist when time clocks or humidistats are used to control the intermittent misting system. Keen observation of the cuttings and the medium, followed by manual adjustment daily, may be needed when operating without environmentally controlled devices. Prolonged periods with or without sunshine can markedly affect time clock adjustments.

1. Time Clock Controls

By far, the most popular intermittent mist system with propagators is time clock controls regulating a solenoid valve. With this type of preset system, two time clocks are required. The day-night or 24 hour timer is used to turn the system "on" in the morning and "off" in the evening at predetermined times, depending on the material being propagated. In addition to the day-night timer, a cycle timer is wired to the solenoid valve to regulate the mist cycle during the hours the day-night timer is "on." Cycle timers for this regulation system are available in several forms, including the 1 minute maximum cycle with 1 second on-off intervals, 6 minute maximum cycles with 6 second on-off cycles and 12 minute maximum cycles with 12 second on-off cycles (Figure 8).

The time clock system must be set to keep cuttings covered with moisture under the most rapid drying conditions. As a result, numerous manual adjustments are required during periods when the evaporation rate is low, i.e., early morning, late evening or cloudy days.

Since environmental conditions change during the rooting period, factors such as light, temperature and humidity also can be used to regulate the intermittent mist system, as discussed in Section B.

2. Humidity Controls

A humidistat has been used in some instances to entirely replace the time clock system in regulating the time of the day during which the mist is applied. However, since drying of the leaves of cuttings is not directly proportional to the level of humidity, this type of control has not been used greatly among propagators.

B. PRESET SYSTEMS WITH ENVIRONMENTAL OVERRIDES

Several control units are commercially available or can be built to overcome the problems associated with an entirely preset system. Such units aid propagators in regulating the mist system to utilize environmental conditions as an override in times of environmental stress.

1. Thermostat Override Controls

Some propagators use the thermostat control system to override the preset cycle of a time clock system that applies the minimum amount of intermittent mist re-

Table 1. Types of Intermittent Mist Propagation Systems and Control Equipment Required

Mode of Operation	Control System	Equipment Required
Entirely preset system	Time	24-hour time clock, interval timer, and solenoid valve
	Humidity	Humidistat and solenoid
Preset systems with environmental overrides	Temperature	24-hour time clock, interval timer, thermostat and solenoid valve
	Light	24-hour time clock, interval timer, photocell and solenoid valve
Environmental cycle	Evaporation	Plastic leaf (2 electrodes in nonconducting substance), electronic relay circuit and solenoid valve
	Weight	Balance, mercury switch, relays and solenoid valve
	Light	Photocell, electronic control unit and solenoid valve

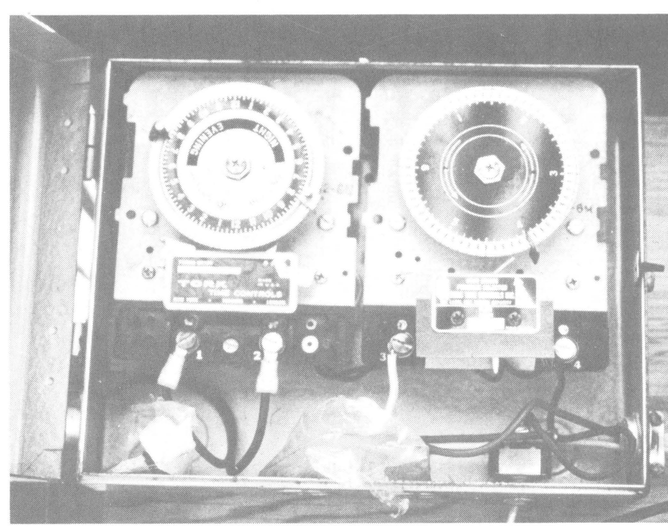

Fig. 8: Time clock used for automatic operation of an intermittent mist system. The 24-hour clock, left, turns system "on" in morning and 'off" in evening. Six-minute interval timer, right, controls interval of mist, Note single tab at 4-minute mark. This allows mist to come "on" for 6 second every 6 minutes.

quired. When temperature conditions around the cuttings rise to a predetermined level, the thermostat overrides the time clock controls and applies a continuous mist until the temperature is reduced below the predetermined level. With this type of system, the temperature of the thermostat is set at the optimum for rooting cuttings and the sensing element (thermocouple) is placed directly above the cuttings.

2. Light Override Controls

This system uses a photocell to override a preset time clock system. The system utilizes a photocell to measure light energy and applies a short period of mist only after a predetermined amount of light energy has been received by the photocell. When using the light operated override system, the amount of misting does not vary; only the interval between applications will vary. Thus the higher the light intensity, the more frequently the mist system will be in operation.

This control system for propagation operates effectively in glass or plastic greenhouses where high humidity can be maintained. Where the propagator is using outdoor beds, evaporation is influenced by wind and humidity conditions as well as light intensity, and the light override system of control has not proved entirely satisfactory.

C. VARIABLE SYSTEM COMPLETELY DEPENDENT UPON ENVIRONMENT

With variable type systems, there are no time clocks to regulate the misting interval or duration. Rather, there are separate systems which depend upon evaporation, weight, or light that control the mist cycle.

1. Electronic Leaf

The electronic leaf is a variable misting system which operates on the principle of evaporation in order to maintain a uniform level of humidity at the leaf surface. This system consists of two electrodes imbedded in plastic or similar nonconductive surface. The electrodes are wired to a central control box which is connected to the solenoid valve.

The electronic leaf operates under the principle that moisture will evaporate from the plastic, nonconductive leaf at about the same rate as it does from the leaf surface of the cuttings. When the moisture between the two electrodes is evaporated and electric contact is broken, the solenoid is activated and the mist is turned on. When a film of water has re-established itself between the two electrodes, the solenoid is deactivated by the control unit and the mist is turned off.

Theoretically, the electronic leaf can maintain a film

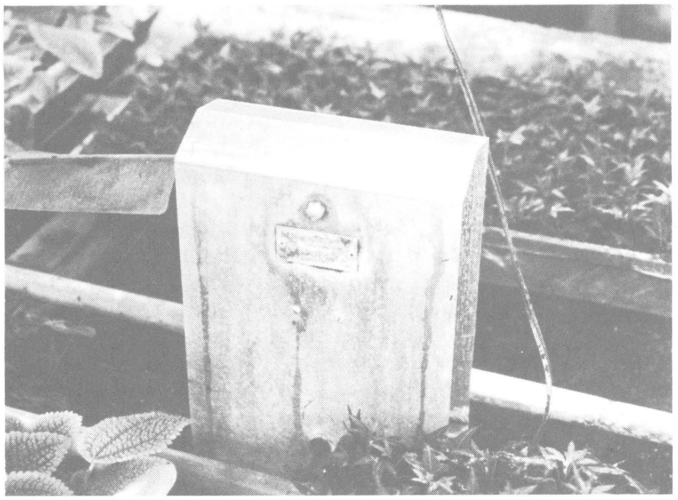

Fig. 9: Control unit for Mist-A-Matic system for regulating the intermittent mist systems. Note stainless-steel screen, left, which activates system.

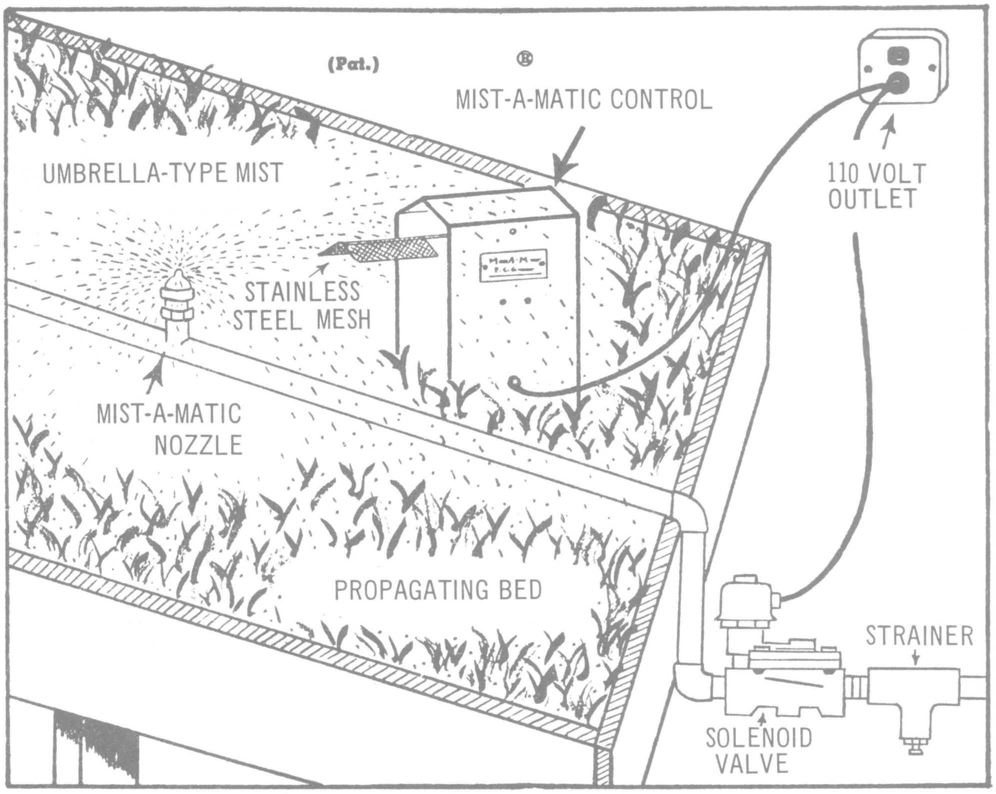

Fig. 10: Schematic diagram of Mist-A-Matic system for propagation. (Courtesy of E. C. Geiger Co., Harleysville, Pa.)

of water on the leaves of the cuttings at all times, thus automatically compensating for changes in the evaporative power of the external atmosphere. This system, however, varies with the placement of the plastic leaf in the propagation bed. When using the electronic leaf system in outdoor propagation beds, it is difficult to properly locate the plastic leaf so that wind drift will not affect the amount of water applied.

In addition, water with a high content of mineral matter or salt will make the operation of the electronic leaf system difficult. Where these water conditions exist, it is common for salts to be deposited in the plastic leaf between the contact points, thus completing the circuit and preventing the water from coming on. To overcome this condition, disconnect the power source from the plastic leaf and remove the accumulated salt from the plastic with a knife blade. Follow this procedure periodically to insure proper working of the electronic leaf system.

2. Weight System (Mist-A-Matic)

Another common system used to regulate the intermittent mist in a propagation bed is based on the weight of water. A small, stainless steel screen is attached to a level which activates a mercury switch. When sufficient water collects on the screen, the screen is lowered. This activates the mercury switch which closes the solenoid, thus turning off the mist. As the water evaporates from the screen, the screen rises and closes the mercury switch, which opens the solenoid and turns on the mist (Figures 9 and 10).

While these systems are advertised as being maintenance free, in reality they require attention similar to that necessary with the electronic leaf. Where water is known to have a high level of salt, the stainless screen must be cleaned periodically to prevent a salt buildup. If neglected, this condition could hold the system permanently in the "on" position. The weight system is most commonly sold under the trade name of Mist-A-Matic (Figures 9 and 10).

3. Solatron

An environmentally dependent light operated system is known commercially as the Solatron system. The Solatron system is used for propagation without 24-hour time clocks or internal timers and operates strictly on light accumulation by the photocell. This completely environmentally controlled system regulates the misting cycle by activating the solenoid valve after a predetermined quantity of foot candles of light is absorbed by the photocell during a given period of time. In addition, the duration of the mist cycle can be adjusted, depending upon the needs of the crop being propagated (Figure 11).

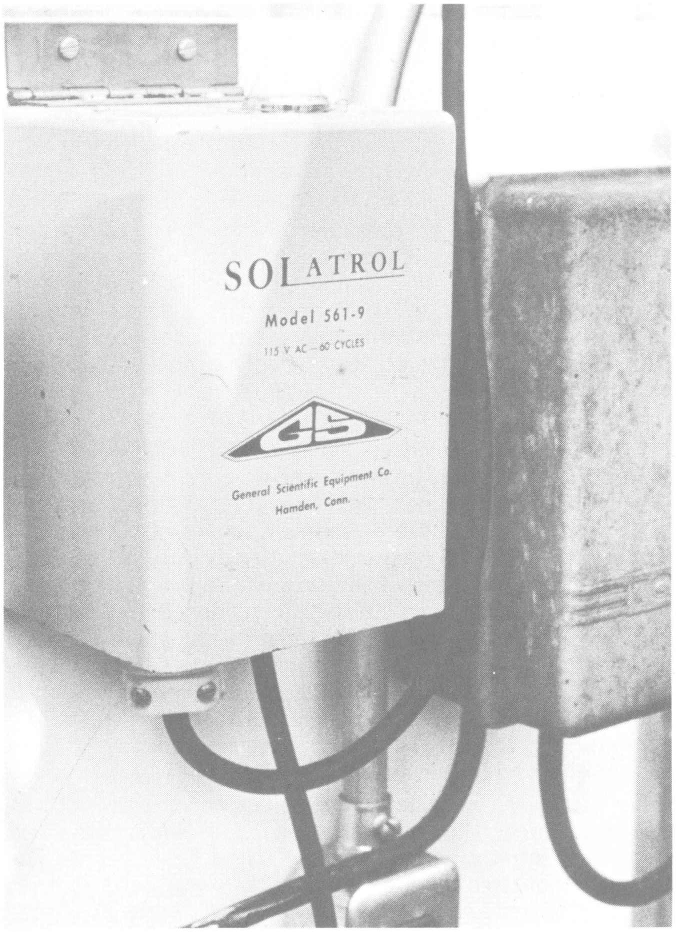

Fig. 11: Solatron system for control of the intermittent mist system.

As with the light operated system used to override a preset time clock system, the Solatron system can be used effectively only in the plastic or glass house situation and has not been proven entirely effective in outdoor propagation beds.

COSTS ASSOCIATED WITH INTERMITTENT MIST PROPAGATION FACILITIES

While much has been written about the principles, techniques, and equipment required in intermittent mist propagation, little information is available concerning the basic prices associated with obtaining this equipment.

Cost of mist controlling devices, nozzles, and other equipment will vary considerably, depending on type, source and quality of equipment selected and the particular requirement of each propagator. There will be cases where booster pumps may be required to increase line pressure, or special filters may be necessary if the water supply has a large amount of particulate matter present. Special equipment of this type obviously would increase the basic cost of the propagation bench.

Cost figures for an intermittent mist system, regulated by a 24-hour time clock with an interval timer are presented in Table 2. These figures are for an existing raised bed where the water source is readily available. Costs for bench construction or actual installation of the intermittent mist system will not be considered in this publication. Nozzle types and the mist control system used in determining the cost of equipment were selected because of their popularity and common usage in the trade. The actual prices of all material listed in Table 2 were derived from 1974 dealer price lists in the catalogs of nursery and greenhouse suppliers.

The Flora-Mist nozzles were selected for this publication because of their common usage in the trade. Cost of other comparable nozzles are listed in Table 3. The Flora-Mist nozzles are designed with a standard ⅛ inch pipe thread and can be inserted into ½ inch PVC pipe when a pipe saddle is used. The pipe saddle is cemented to ½ inch PVC pipe where a nozzle is desired. Using a 5/16 inch drill, a hole is drilled in the ½ inch PVC pipe following the attachment of the pipe saddle to the feeder line, and the Floral Mist nozzle is then inserted into the pipe saddle.

Other regulatory systems such as the electronic leaf, Solatron and Mist-A-Matic have been discussed as to their operation. Cost figures for these three systems are listed at 1974 dealer prices in Table 2. While these systems will increase the cost of the intermittent mist bed, it must be noted that they are much more sensitive systems and ultimately give better control of mist and water level in the propagation bed.

Table 2. Supplies and Equipment Necessary to Install an Intermittent Mist System in an Existing Raised Propagation Bench 4 ft. × 50 ft. Prices from 1974 Distributor Price Lists.

Supplies/ Equipment Quantity (Feet)	Description	Cost	
50	½ inch PVC Pipe at $2.99 per 100 feet	$ 1.50	
17	Flora-Mist Fogger Nozzles at $.54	9.18	
2	½ inch PVC T's at $.35	.70	
2	½ inch PVC 90° ELLS at $.34	.68	
1	½ inch PVC Cap at $.19	.19	
17	½ inch PVC Pipe Saddles at $.15	2.55	
1	½ inch Solenoid Valve at $28.20	28.20	
1	24 Volt Transformer at $5.75	5.75	
1	½ inch Globe Valve at $3.00	3.00	
4	½ inch PVC TXS Male Adapters at $.16	.64	
1	½ inch Line Strainer at $4.75	4.75	
	EQUIPMENT SUBTOTAL	**57.14**	
1	24-Hour Time Clock	14.95	
1	Interval Timer—6 minute cycle with 6 second adjustable increments	29.50	
	Total with Time Clock System		**$101.59**
1	Mist-A-Matic Control System	98.75	
	Total with Mist-A-Matic		**155.89**
1	MacPenny Electronic Leaf	105.00	
	Total with MacPenny Electronic Leaf		**162.14**
1	Solatron—Model 561-9	139.50	
	Total in Solatron System		**196.64**

When the electronic leaf system is used, the 24-hour time clock and interval timer are excluded. However, the total cost of the propagation system increases to $162.14, based on the 200 square foot model. With the Mist-A-Matic system, the 24-hour time clock and interval timer are again excluded, but the total cost increases to $155.89 in the same model. Likewise, the Solatron system operates without either of the time clocks, but increases total cost of the system to $196.64.

Table 3. Characteristics and Cost of Some Commonly Used Nozzles for Intermittent Mist Systems

Description	Type	Area of Coverage ft. dia.	Operating Pressure lbs./sq. in.	Rate of Discharge gal./hr.	Cost	Comments
Flora-Mist Fogger	Deflection	6-7	40	4-14	$ .60	1/32 inch orifice ⅛ inch std. pipe threads
Mist-er Green Fogger	Deflector	5-7	20 40 60	12 17 20	1.10	.040 inch orifice 5/16-24 machine threads
Fog-Mist Nozzle #550	Deflection	4	20	6	3.60	⅜ inch std. pipe threads
Fog-Mist Nozzle #551	Deflection	4	20	6	1.95	⅛ inch std. pipe threads
Jed-Mist Nozzle	Deflection	4	40	1	.75	5/16-24 machine threads
Eddy-Mist Nozzles	Deflection	12	45	90	.60	Requires adaptor
Supreme Electric A6	Oil Burner	3-4	100	15	3.00	½ inch pipe fitting
Supreme Electric T16	Oil Burner	15	50	1.5	5.00	

SUMMARY

Intermittent mist is the principle commercial means of applying water to cuttings in a propagation bed.

A strainer mounted in the water line in front of the solenoid valve helps insure longer solenoid and nozzle wear.

The flow of water through the misting system is controlled by a solenoid valve. The naturally-open solenoid valve provides water to the bench in the case of a power failure.

Although both oil burner and deflection type nozzles are seen in the trade, the latter is the most common since it covers a greater area, operates with low water pressure, requires less maintenance, and is less expensive.

One of three systems can be used to control the frequency and duration of misting. The most common system involves the use of preset time clocks. A thermostat or photocell may be utilized, in conjunction with a time clock mechanism, to override the system in times of stress. The third system utilizes the principle of evaporation (electronic leaf), weight of water (Mist-A-Matic) or photocell (Solatron) to control the misting system.

A list of supplies and equipment needed for an intermittent mist system for a 200 square foot bed has been prepared along with suggested prices.

Note: The hazard of electric shock should always be kept in mind when working with any electrical control unit in a mist bed when considerable water is present. The complete installation should be done by a competent electrician.

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